On some tree-frogs allied to Hyla caerulea

with remarks on noteworthy secondary sexual characters in the family Hylidae.

By

G. A. Boulenger, F. R. S., Ph. D. (Gießen), in London.

In their great work [1]), Duméril and Bibron have confounded, under the name of *Hyla cyanea* Daudin, two perfectly distinct species. The first, which by right of priority should bear the name of *H. caerulea* White (the later *cyanea* Daud., being a strict synonym), has been excellently described and figured by Günther [2]) as *Pelodryas caeruleus*, from Australian specimens; it has a wide distribution in Australia, and occurs also in New Guinea. The second, figured and recorded from Amboina and New Guinea by Schlegel [3]), and which occurs also in other islands to the west of New Guinea and in Queensland, was well characterized by Cope [4]) under the name of *Calamita dolichopsis*.

The distinction drawn by Cope was upheld by me when revising the British Museum collection [5]) and the names *H. caerulea* and *H. dolichopsis* have been accepted by subsequent writers. A third supposed species, *H. infrafrenata* Gthr. [6]), I reluctantly admitted in the system for lack of sufficient material, but I am now absolutely convinced that it is based on a young *H. dolichopsis*, as suggested by

1) Erpétologie Générale, Vol. 8, p. 577 (1841).
2) Catalogue of the Batrachia Salientia, p. 119, pl. 9, fig. B (1858).
3) Abbildungen neuer oder unvollständig bekannter Amphibien, p. 26, pl. 9, fig. 2 (1837).
4) Journ. Acad. Philad. (2), Vol. 6, p. 204 (Sept. 1867).
5) Catalogue of the Batrachia Salientia s. Ecaudata (1882).
6) Ann. Mag. Nat. Hist. (3), Vol. 20, p. 56 (June 1867).

L. von Méhely [1]) and Van Kampen [2]). This conclusion unfortunately necessitates a change in the name of the common Papuasian species, as *H. infrafrenata* beneficiates of two months earlier date in publication over *H. dolichopsis*. This is particularly unfortunate as the species was so clearly defined by Cope from adult specimens, whilst Günther based his name on a young, at a time when he refused to regard the adult as more than a variety of *H. caerulea*.[3])

Since the publication of the British Museum Catalogue, the collection of Australian and Papuasian frogs has been considerably increased, and it is necessary to reconsider the definition of the two species, *H. caerulea* and *H. infrafrenata* (*dolichopsis*), in the light of the new material, which includes examples of what appears to represent three further, closely related species.

As regards the true *Hyla caerulea*, originally described from New South Wales specimens, and of which examples are often received alive in Europe, we have now before us a large series, from the following localities:

New South Wales: Sydney, Tamworth (D. A. Porter).
Queensland: Moreton Bay, Port Mackay (H. Ling Roth), Cooktown (H. Ling Roth, Bellenden Ker).
Northern Territory: Port Essington (Earl of Derby, Gould), Port Darwin (R. G. S. Buckland), Alexandria (W. Stalker).
Western Australia: Nicol Bay (Du Boulay), Roebuck Bay (Dahl).
Islands of Torres Straits: Murray Island (S. Macfarlane), Thursday Island (Coppinger), Mer Island (Haddon).
New Guinea: Dinawa, Owen Stanley Range (Pratt).

Measurements of a number of these specimens are given below, and a study of the series necessitates the following corrections and emendations to the description previously given by me:

As already stated by Günther, the fingers may be as much as half webbed, whilst in a female from New South Wales (No. 12 of table of measurements), they are barely one fourth webbed. The disks of the fingers, in the same specimen, are smaller than the tympanum [4]), whilst in an other female from Queensland (No. 1 of table)

1) Term. Fuz. Budapest, Vol. 20, 1897, p. 413; Vol. 21, 1898, p. 176.
2) Nova Guinea, Vol. 5, Zool., p. 172 (1906).
3) Zool. Record for 1867, p. 148 (1868).
4) The position of the vomerine teeth on a level with the posterior border of the choanae excludes the possibility of such a specimen representing Duméril and Bibron's *H. jervisiensis* from New South Wales.

they are not only larger than the tympanum, but nearly as large as the eye. Young specimens (No. 18 of table) have the diks considerably smaller than the tympanum, and this fact is specially worthy of note in view of the identification of *H. infrafrenata* with *H. dolichopsis*. The subgular vocal sac of the male during the breeding season may be described as external.

The green coloration (turning to blue or purple in spirit) is characteristic of this species, and seems far less subject to changes than in our European tree-frog. However, as I have mentioned before, white, dark-edged spots or streaks may be present or the sides of the body and limbs and on the upper lip; but there is not the least indication of the white or yellow border to the lower jaw which is constant in *H. infrafrenata*.

The second species, described almost simultaneously from a young specimen from Cape York, Queensland, as *Hyla infrafrenata*, and from adult from Amboina as *Calamita dolichopsis*, is easily distinguished by the longer hind limbs; when these are bent forwards against the body, the tibio-tarsal articulation reaches beyond the eye, often to the tip of snout or beyond (the temple or the eye in *H. caerulea*), and the crus or tibia is more than half the length of head and body (less than half in *H. caerulea*). The snout is longer and the head is devoid of the dermal thickening, comparable to parotoids, on which the family *Pelodryadidae* was founded by Günther, and which give the common Australian species the peculiar appearance so well rendered in the Cambridge Natural History.[1]) A white or yellow streak, edged with green, borders the lower lip; there is often a white or yellow, continuous or interrupted, sometimes wavy streak, along the inner edge of the tibia, this streak being well marked in the type of *H. infrafrenata*, and I find it, interrupted, in a specimen from Amboina, the type locality for *H. dolichopsis*. How much the relative proportions of the tympanum and digital disks vary, the table of measurements here given sufficienty indicates. An osteological charakter, not previously pointed out, which distinguishes this species from *H. caerulea* resides in the nasal bones, which are mesially in contact or narrowly separated in the former, and very widely separated in the latter.

Hyla infrafrenata is remarkable for a secondary sexual character which does not appear to have been noticed before and which, so

1) H. Gadow, Amphibia and Reptiles, p. 199 (1901).

far as my knowledge goes, is unique in the family *Hylidae*. It is mentioned in the generic definition of *Hyla* that the omosternum is cartilaginous, and so it is in *H. caerulea*. But the males of *H. infrafrenata* are provided with a sharp pointed process in the middle of the breast, at the base of the vocal sac, and this process, which can easily be felt under the skin and shows very distincty in somewhat shrivelled up specimens, is formed by an ossification of the omosternum; this bone is slightly curved upwards in front, and its posterior part penetrates between the praecoracoids. How far this remarkable structure is connected with the nuptial embrace can only be determined by and examination of specimens in copula.

As regards the nuptial horny excrescences on the inner side of the first finger, which are similar in appearance to those of our common frog, *Rana temporaria*, it is desirable to state here that a difference on which the late Prof. Boettger partly based his var. *tenuigranulata* [1]), from Halmaheira and Ternate, is not a constant one, since the two groups of rugosities may be perfectly separated from each other, narrowly connected, or fused together to form an uninterrupted patch. I may even note that in one specimen, from Bowen, the patches are distinct on the right side and continuous on the left. The other characters on which the var. *tenuigranulata* are based, viz. the tubercular granulation of the upper parts and the relative size of the digital disks and the tympanum, I find to occur likewise in some specimens from other parts of the habitat, so that, in my opinion, it does not deserve to stand even as a geographical variety. I also regard *H. aruensis*, Horst [2]) from the Aru Islands and Misol, and *H. sanguinolenta*, van Kampen [3]), from New Guinea, as further synonyms of *H. infrafrenata*.

The same is not the case with the tree-frog from the Bismarck Archipelago, for which Werner has proposed the name *H. dolichopsis, var. pollicaris* [4]), in allusion to the presence of a projecting rudiment of pollex, of which no trace is to be seen in the otherwise similar specimens from New Guinea and the Moluccas. The extremity of the metacarpal of the pollex is pointed and bent outwards at an oblique angle to the axis of the bone, and is indicated externally by a distinct knob on the inner side of the inner finger. This

1) Zool. Anz., 1895, p. 136.
2) Notes Leyd. Mus., Vol. 5, 1883, p. 342.
3) Nova Guinea, Vol. 9, Zool., p. 33, pl. 11 fig. 3 (1909).
4) Zool. Anz., 1898, p. 554.

character is well shown by the two specimens, male and female, from Duke of York Island in the British Museum, and in the 8 specimens (Ralum and New Britain) examined by Dr. Werner, and as it appears to afford a safe character for diagnosing species among the American tree-frogs, I would, provisionally at least, assign specific rank to the Bismarck Archipelago form, which should bear the earlier name *Hyla militaria* Ramsay, specimens from New Britain having been described by E. P. Ramsay [1]) as *Pelodryas militarius*. I may add that *H. militaria* agrees with *H. infrafrenata* in the wide separation of the nasal bones.

Leaving out the Bismarck Archipelago form, the distribution of *H. infrafrenata* can be traced as follows: Talaut Islands, Gilolo (Halmaheira), Misol, Buru, Ceram, Amboyna, Timor, Tenimber Islands (Timor Laut, Larat), Kei Islands, Aru Islands, New Guinea, Islands of Torres Straits, Queensland (Cape York, Cooktown).

The British Museum Collection contains examples of two further frogs, which I had first referred to *H. dolichopsis*, but which I am now convinced represent two undescribed species, for which I would propose the names of *Hyla spengeli* and *H. humeralis*.

Hyla spengeli sp. n. is based on a single female specimen from Dinawa, Owen Stanley Range, British New Guinea, a locality where both *H. caerulea* and *H. infrafrenata* are known to occur. As it is in some respects intermediate between the two, it might be thought to be a hybrid, were it not for the size of the tympanum, which is much greater than in either of the species to which it is most nearly related.

Head as in *H. infrafrenata*; the distance between the tip of the snout and the eye is twice the diameter of the latter. Eye, tympanum, and disk of third finger nearly equal in size. Outer fingers half webbed; no projecting rudiment of pollex. Tibio-tarsal articulation reaching the eye; tibia not half length of head and body. Skin smooth above, strongly corrugated on the sides, granular on the belly and under the thighs. From snout to vent 115 millim. Bluish lilac above (in spirit); a white streak, edged with dark purple, borders the lower jaw, and extends to above the shoulder; a whitish streak along the outer side of the fore-arm and outer finger and of the tarsus and outer toe, prolonged a short way up the inner side of the

1) Proc. Linn. Soc. N. S. W., Vol. 11, p. 28 (1878). — Macleay's *Pelodryas militarius* (l. c., p. 138) is, on the other hand, probably a synonym of *H. infrafrenata*.

Table of measurements.

	H. caerulea																	*H. infrafrenata*		
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13	14.	15.	16.	17.	18.	19.	20.	21.
From snout to vent	100	98	92	85	83	82	80	80	78	72	72	70	69	62	62	61	60	35	135	120	116
Head	29	28	25	24	26	24	24	24	23	21	21	19	19	19	19	19	18	12	40	35	38
Width of head	40	39	31	28	31	26	29	28	27	27	24	25	21	21	22	22	20	13	47	42	42
Snout	10	9	9	8	8	7	9	8	8	7	8	6	7	6	7	6	6	4	17	14	15
Eye	9	9	8	7	8	7	7	7	7	7	7	7	6	6	6	6	6	4	11	10	11
Tympanum	6	6	5	5	6	5	6	5	5	5	5	5	4	4	4	4	$3^1/_2$	$2^1/_2$	8	8	8
Fore limb	63	58	54	48	50	45	48	48	48	45	41	42	39	37	37	37	38	20	90	83	82
Hand	31	30	26	23	25	22	23	24	23	22	19	20	20	17	17	18	17	10	46	40	41
Disk of third finger	8	6	6	5	5	5	5	5	5	5	5	4	4	$3^1/_2$	4	4	$3^1/_2$	$1^1/_2$	10	10	9
Hind limb	140	126	120	110	112	107	108	102	110	105	95	94	93	84	82	88	82	47	213	205	190
Tibia	45	40	38	34	35	34	34	33	35	32	30	30	30	27	26	27	27	15	68	66	63
Foot	42	39	35	31	32	29	31	30	32	30	27	27	27	24	24	24	24	14	60	54	54
Disk of fourth toe	7	6	5	4	5	4	4	4	4	4	4	3	$3^1/_2$	3	3	4	3	$1^1/_2$	8	8	7

1. ♀ Port Mackay, Queensland.
2. ♀ Queensland.
3. ♀ Port Darwin.
4. ♀ Alexandria, N. Territory.
5. ♀ Port Essington (Derby).
6. ♂ Nicol Bay.
7. ♂ Port Essington (Gould).
8. ♀ Nicol Bay.
9. ♂ Port Essington (Gould).
10. ♂ Cooktown, Queensland.
11. ♂ Alexandria, N. Territory.
12. ♀ Tamworth, N. S. W.
13. ♀ } Mer Island, Torres Str.
14. ♂ }
15. ♀ Moreton Bay.
16. ♀ Dinawa, New Guinea.
17. ♀ Murray Island, Torres Str.
18. Yg. Sydney.

tibia. The coloration is, in fact, exactly as in some specimens of *H. infrafrenata*. Nasal bones widely separated from each other.

The unique specimen was obtained by Mr. A. E. Pratt in 1903.

Hyla humeralis, sp. n. is based on two male specimens (one of which has been made into a skeleton) from Madew, St. Joseph River, British New Guinea, between 2000 and 3000 feet, collected by the late W. W. Stalker in 1908, and presented to the Museum by Sir W. Ingram. It is also very closely allied to *H. infrafrenata*, but it differs in the smaller tympanum, the reverse of *H. spengeli*, and in the remarkable armature of the fore limb, whence the name *humeralis*.

Head more depressed than in *H. caerulea* and *H. infrafrenata*; the distance between the tip of the snout and the eye but little greater than the diameter of the latter. Tympanum very small, $^2/_5$ the diameter of the eye. The upper, transparent part of the lower eyelid is veined with purple (no doubt green in life), a character which does not occur in the allied species. Outer fingers nearly half webbed; no projecting rudiment of pollex; disk of third finger nearly

in millimetres.

H. infrafrenata																			*H. militaria*		*H. spengeli*	*H. humeralis*
22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.
14	113	110	108	102	99	98	95	95	90	90	84	81	75	70	67	66	60	50	45	108	105	115	100
33	32	33	32	29	28	30	27	28	27	27	25	23	22	21	21	21	19	17	15	32	33	33	31
38	39	38	37	32	31	33	31	31	29	29	27	25	25	24	23	23	21	18	16	37	37	38	36
14	13	14	13	12	12	13	11	11	11	10	9	9	9	8	9	8	7	6	6	13	15	15	10
10	10	9	10	9	10	10	9	9	9	9	8	8	7	7	7	7	6	6	5	10	10	9	10
7	8	7	6	7	6	7	6	6	6	6	6	5	5	5	5	4	4	$3\frac{1}{2}$	$3\frac{1}{2}$	6	$6\frac{1}{2}$	9	4
75	77	74	72	74	63	68	65	62	55	55	53	54	50	47	41	45	38	30	29	72	74	76	65
38	36	39	36	32	30	31	31	30	28	29	27	25	24	22	20	21	19	15	14	36	35	36	34
9	7	8	7	6	6	6	6	6	6	6	6	6	5	5	4	5	4	$2\frac{1}{2}$	2	7	7	8	8
203	195	185	175	170	165	175	165	158	148	142	140	135	126	122	110	113	105	85	77	175	174	167	175
66	62	61	57	57	54	57	55	52	49	48	45	45	42	41	37	38	35	29	26	57	57	52	59
53	49	52	49	43	41	43	41	41	40	38	37	34	32	31	28	30	27	20	19	49	46	47	45
17	6	7	6	5	5	6	5	6	5	5	5	5	4	4	3	4	3	2	$1\frac{1}{2}$	6	?	7	7

19. ♀ N. Queensland (Melbourne Mus.).
20. ♀ Ferguson Island, New Guinea.
21. ♀ Great Kei Island.
22. ♀ Misol.
23. ♀ Maupa, New Guinea.
24. ♀ Cooktown, Queensland.
25. ♀ Amboyna.
26. ♀ Timor Laut.
27. ♂ Mimika R., New Guinea.
28—30. ♂ Gilolo.
31—34. ♂ Ceram.
35—36. ♀ Larat Tenimber Islands.
37. ♀ Dinawa, New Guinea.
38—39. ♂ Kayeli, Buru.
40. Yg. Trobriand Islands, New Guinea.
41. Yg. Cape York (Type).
42. ♀ } Duke of York Island.
43. ♂ }
44. ♀ Dinawa, New Guinea.
45. ♂ Madew, New Guinea.

as large as the tympanum. Tibio-tarsal articulation extending a little beyond the tip of the snout; tibia more than half length of head and body. Upper parts with scattered small granular warts, some of which are capped with deciduous, conical, black horny tubercles; sides, belly, and lower surface of thighs granulate. From snout to vent 100 millim. Purple above (in spirit), more pinkish round the eyes, on the arms, sides of thighs, and hands and feet, white beneath; no light border to the lower jaw. Nasal bones widely separated from each other.

The male is provided with a moderately-developed external subgular vocal sac. The remarkable secondary sexual characters which distinguish it from the males of the allied species reside in the presence of a spine-like process on the front side of the proximal part of the shaft of the humerus, and of two deciduous black horny plates studded with spines, on the inner side of the inner finger. The humeral spine is curved, acutely pointed, and directed outwards; it may be felt under the skin on each side of the breast. The black horny plates consist of a large, transversaly oval convex patch on the metacarpal,

which is enlarged and bent inwards, and a smaller one on the basal phalanx; the sharply pointed conical spines with which they are studded are so large that they can be distinguished with the naked eye. In *H. caerulea* and *H. infrafrenata*, the black nuptial rugosities consist of isolated small spines crowded together in one or two patches as in our *Rana temporaria*. As in *H. caerulea*, the omosternum is quite normal, cartilaginous.

It is very remarkable indeed to find two species so closely related as *H. infrafrenata* and *H. humeralis* differing so strikingly in the characters connected with the nuptial embrace, although we are not unprepared for such discrepancies. The late Prof. Boettger has described [1]) a small tree-frog from Costa Rica, *Hyla prosoblepon*, in which a sword-shaped bony process is present on the inner side of the arm. Another species, from Bolivia, named by me *Hyla armata* [2]), bears three large black, horny, pluricuspid nuptial plates, one under the arm, two close together on the inner side of the inner finger. The use of these plates is evidently for the male to clasp more securely the female during the breeding operations, but the way in which the plates on the fingers are exactly opposed to that on the arm suggests the possibility of their being also stridulating organs. In the male of *Cauphias guatemalensis* Brocchi [3]), the rudimentary pollex terminates in a very sharp spine at right angle to the inner digit. Among the secondary sexual characters in the *Hylidae*, the large flat gland on the side of the male *Hyla rosenbergii* Blgr. [4]) deserves mention as analogous to the humeral gland of *Pelobates*, the function of which in still unexplained. As a general rule, nuptial or copulatory horny excrescences are absent or very feebly developed in the *Hylidae*, although there are exceptions, as in the South American *Hyla leprieuri*, which may even possess them under the toes; and again, closely allied species may show much difference in this respect, as for instance *Hyla arborea* and *H. chinensis*. It is however worthy of note that, whilst brown or black horny rugosities are rather the exception in the American forms (only about a dozen S. American *Hylidae*, *Phyllomedusa*, *Triprion*, being provided with them), their presence is the rule in the species of *Hyla* and *Hyllella* inhabiting Australia and Papuasia.

1) Kat. Batr. Senckenb. Ges., 1892, p. 45. — It is through an oversight that I ascribed the character in question to another tree-frog from Costa Rica, *Hylella fleischmanni* Boettg., in: Les Batraciens (Paris 1910), p. 165.

2) Ann. Mag. Nat. Hist. (7), Vol. 10, 1906, p. 294.

3) Mission Scient. au Mexique, Batraciens, p. 63, pl. 12, fig. 3 (1882).

4) Proc. Zool. Soc., 1898, p. 123, pl. 16.